INTRODUCTION TO LITHOSPHERIC GEODYNAMIC MODELLING

COURSE OVERVIEW

Lars Kaislaniemi and David Whipp

9-13 January 2017

LET'S GET TO KNOW ONE ANOTHER

WHO ARE WE?

- Dave Whipp, Associate professor
  - Geodynamics of convergent orogens
  - Geomorphology
- Lars Kaislaniemi, Postdoctoral researcher
  - Geodynamics of the Bolivian Andes
  - Mantle dynamics and geochemistry

WHO ARE YOU?

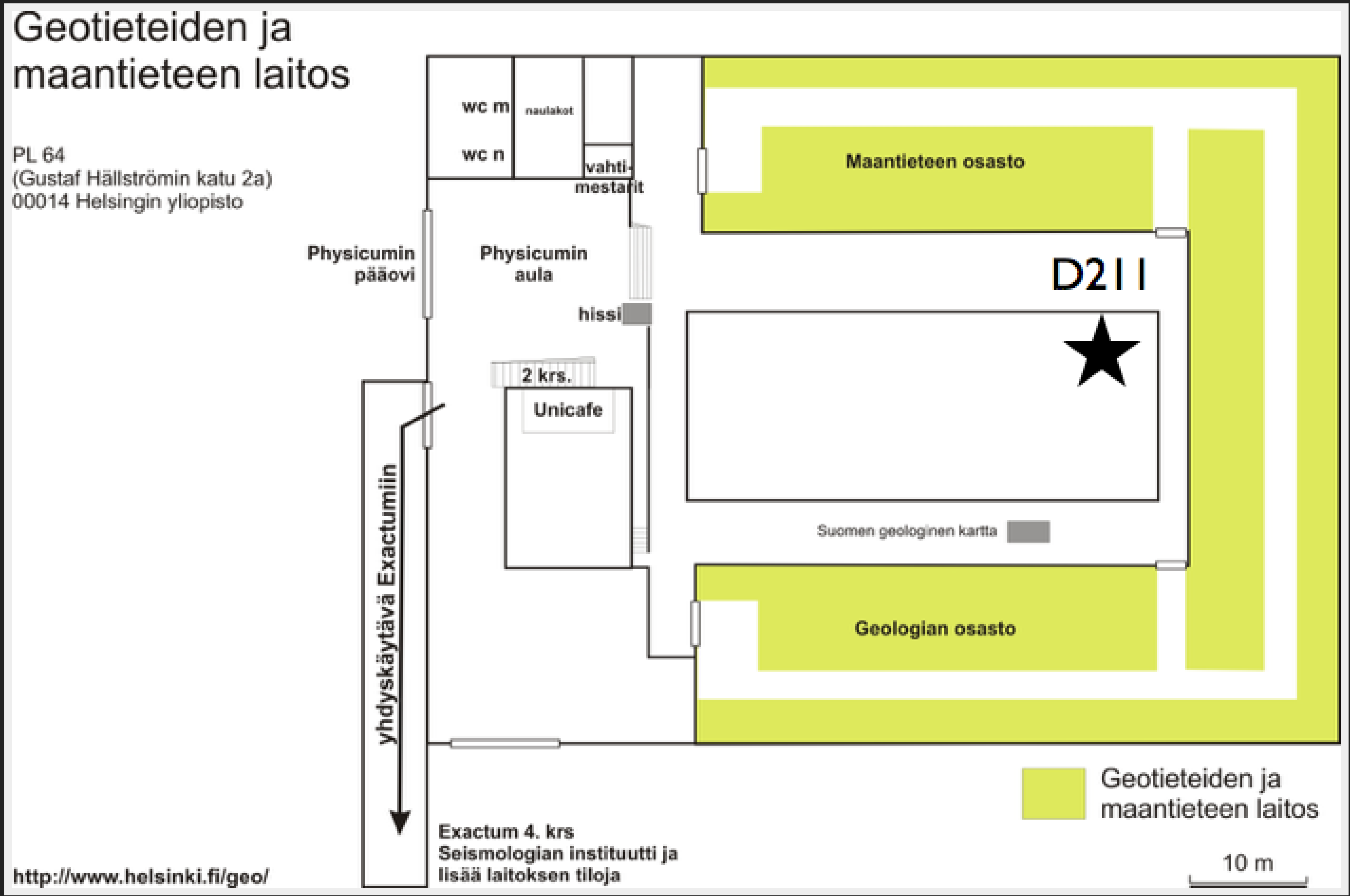
- Name
- Home university & program
- Status (Ph.D. student, MSc, etc.)
- Thesis topic
- Experience with coding and/or modelling

TIME TO PAIR UP

- Before you get too comfortable please find a partner to work with for the rest of the course
  - Ideal partnership: A stronger coder/modeller with someone with less coding/modelling skill
  - Groups of 3 are possible, but only if needed

PRACTICAL MATTERS

WHERE ARE WE?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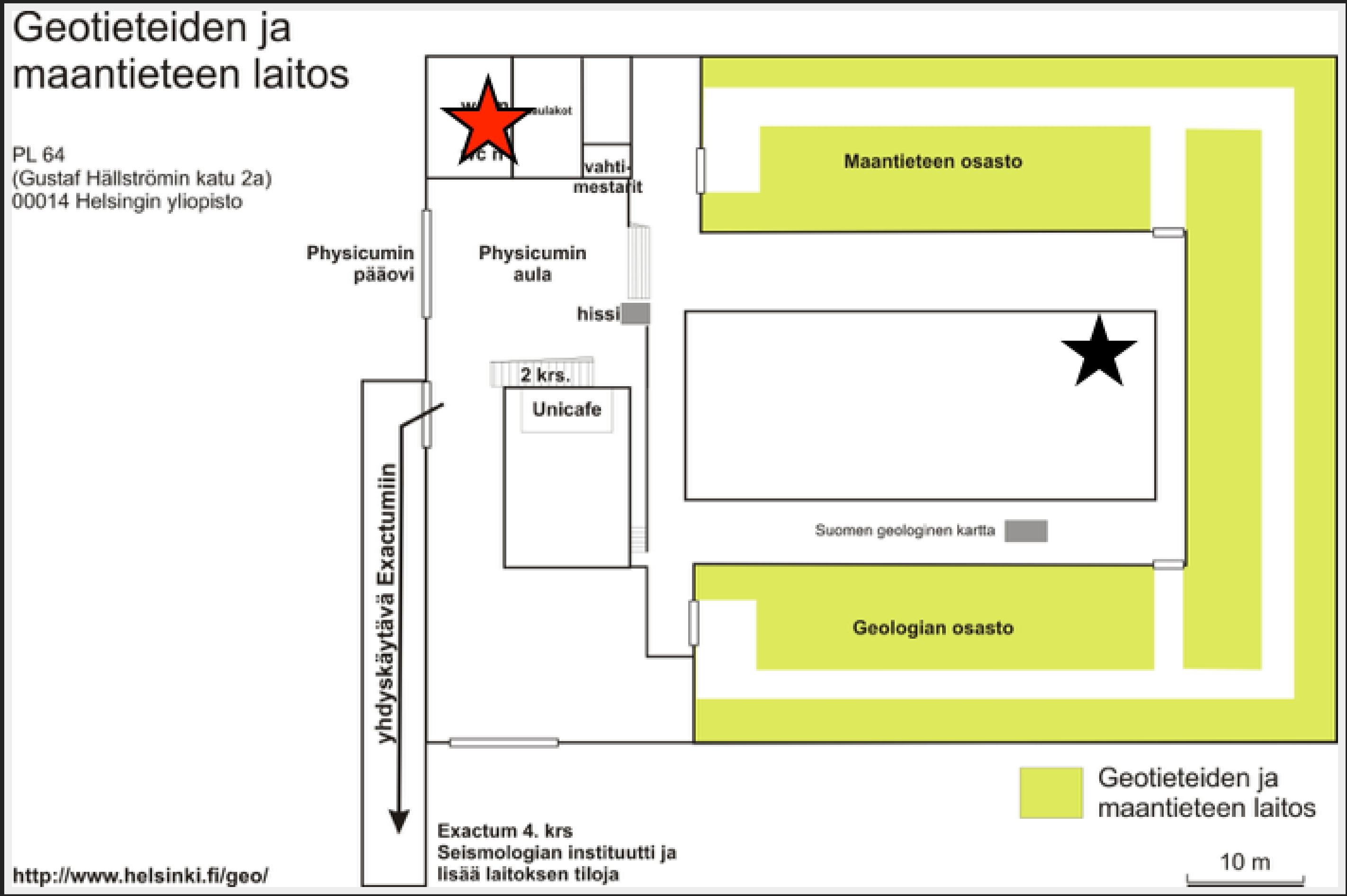
TOILETS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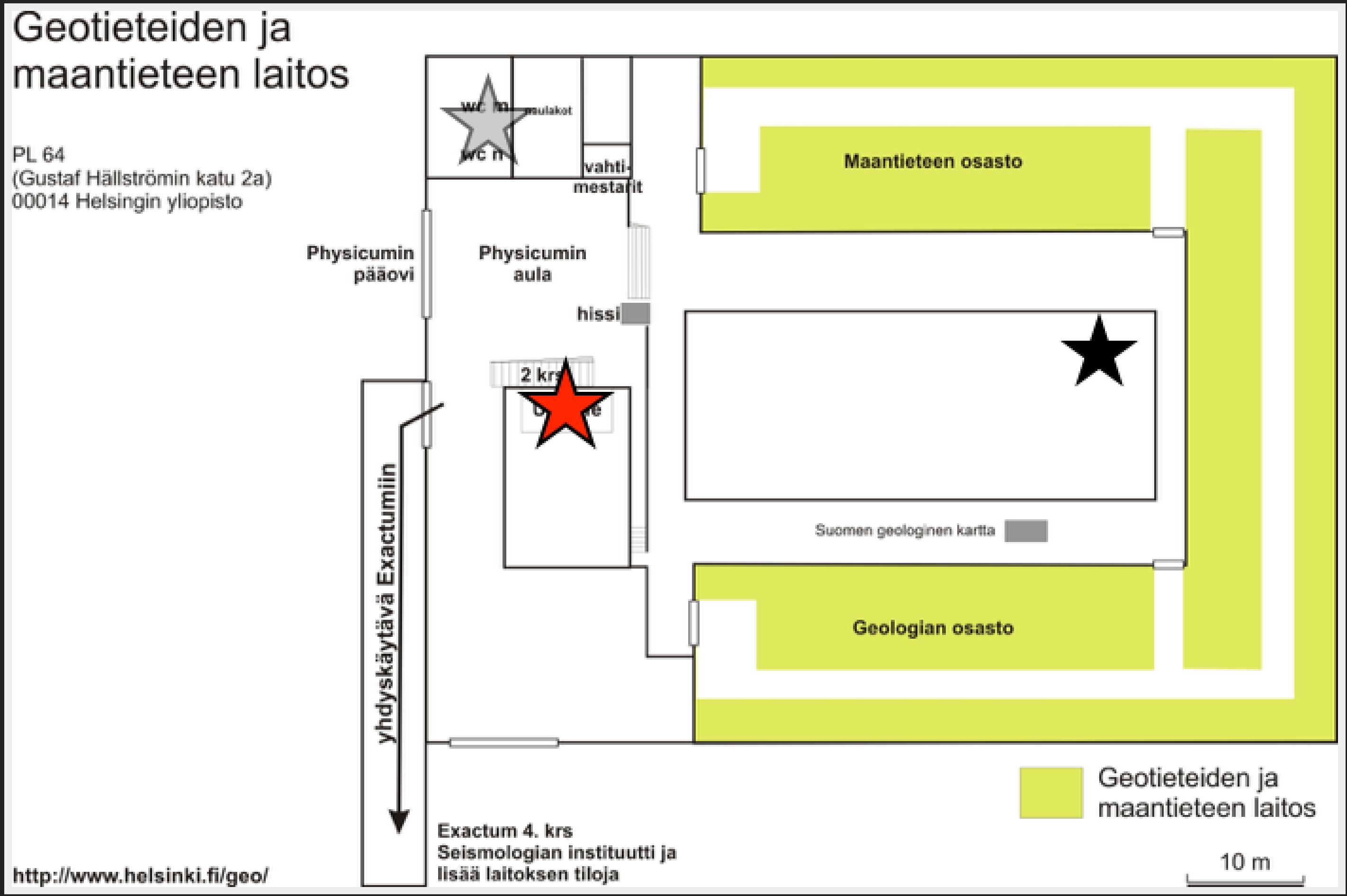
COFFEE/TEA



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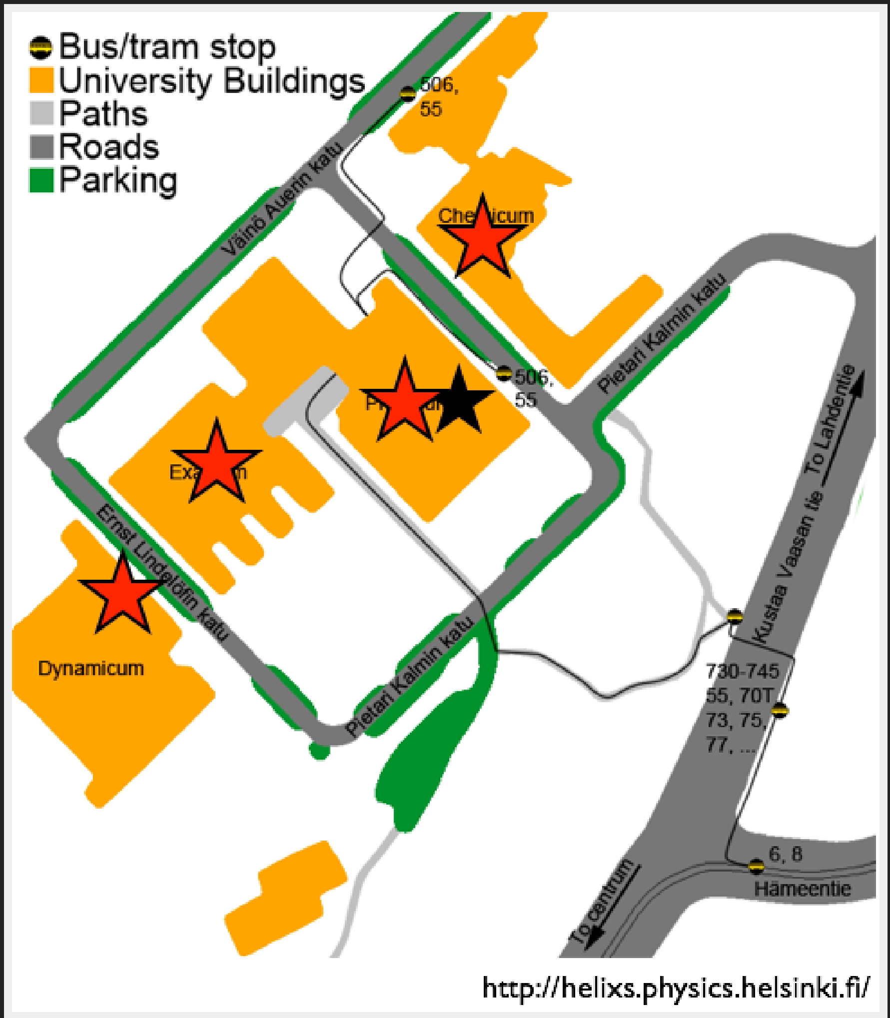
LUNCH



- You can get a **full hot lunch**
  - Across the street in the Chemicum
  - In the basement of the Exactum next door
  - Slightly further away in the Dynamicum (pricier, but a bit better).
- The Unicafe (coffee/tea spot) also has **sandwiches/paninis**

COMPUTER STUFF AND COURSE WEBSITE

COMPUTERS IN THIS CLASSROOM

- As far as we know, computers in this classroom require a University of Helsinki IT account
  - Visiting students are welcome to use their own computers to participate in the course
  - If you don't have a University of Helsinki account or your own computer to use, talk to Lars or myself at the first break

SOFTWARE

- All software used in this course is freely available
  - A list of software available for download is provided on the course website (next slide)

COURSE WEBSITE

- All course materials will be posted to a GitHub page for the course
  - This page will provide links to lecture slides, scripts used for the course, and other materials
  - We will be updating the page as we go, but at the end of the course, you're welcome to download the entire course
    - The materials are freely available for use by anyone, subject to the license, so feel free to share with your friends/colleagues!

COURSE GOALS AND LEARNING OBJECTIVES

COURSE GOALS

- Understand the fundamental physical equations solved in numerical geodynamic models, how they work, and how they affect numerical experiments
- Learn how to convert the main equations used to model lithospheric deformation into simple programs
- Develop a background understanding of geodynamics that allows you to properly understand the behavior of geodynamic numerical models

LEARNING OBJECTIVES

At the end of this course, students should be able to:

- Solve partial differential equations using the finite-difference method
- Differentiate between and implement various boundary and initial conditions in numerical models
- Create their own simple 2D numerical geodynamic model including heat transfer and viscous flow

WORKING METHODS

The course involves a combination of lectures and computer-based exercises

- We will try to keep lectures to a minimum, but we do need to present some material you will need to complete the computer exercises
- For the computer exercises, you should work together with your partner and we will discuss your solutions after you have completed each exercise
  - We have not previously taught this course, nor have we given these exercises before, so we hope they will prove challenging, but not impossible :)

SCHEDULE

Press the down arrow to view each day

DAY 1

Schedule subject to change

09:00-09:30 - Course overview and introductions
09:30-10:20 - Key physical processes/concepts

10:20-10:35 - ***Coffee/tea break***

10:35-11:15 - Key physical processes/concepts (ctd.)
11:15-11:45 - Solving equations
11:45-12:00 - *Computer setup/introduction* (optional)

12:00-13:00 - ***Lunch***

13:00-14:20 - Python/computing essentials

14:20-14:35 - ***Coffee/tea break***

14:35-16:00 - Python/computing essentials (ctd.)

DAY 2

Schedule subject to change

09:00-10:20 - The finite difference method, part I

10:20-10:35 - ***Coffee/tea break***

10:35-11:15 - The finite difference method, part I (ctd.)
11:15-12:00 - Code review for the Stokes ball example

12:00-13:00 - ***Lunch***

13:00-14:20 - Heat conduction in 1D

14:20-14:35 - ***Coffee/tea break***

14:35-15:30 - Heat conduction in 1D (ctd.)
15:30-16:00 - Code review of heat conduction in 1D

DAY 3

Schedule subject to change

09:00-10:20 - Testing your code/benchmarking

10:20-10:35 - ***Coffee/tea break***

10:35-12:00 - 1D advection of a field

12:00-13:00 - ***Lunch***

13:00-14:20 - Heat transfer in 1D

14:20-14:35 - ***Coffee/tea break***

14:35-16:00 - The finite difference method, part II

DAY 4

Schedule subject to change

09:00-10:20 - Heat transfer in 2D

10:20-10:35 - ***Coffee/tea break***

10:35-12:00 - 2D heat transfer (ctd.)

12:00-13:00 - ***Lunch***

13:00-14:00 - State of your code for heat transfer in 2D
14:00-14:30 - Debugging your code - Pro tips

14:30-14:45 - ***Coffee/tea break***

14:45-15:15 - The marker-in-cell technique
15:15-15:45 - Putting it all together
15:45-16:00 - Overview of the remainder of the course

DAY 5

Schedule subject to change

09:00-10:20 - Stokes flow in 2D

10:20-10:35 - ***Coffee/tea break***

10:35-12:00 - Stokes flow in 2D (ctd.)

12:00-13:00 - ***Lunch***

13:00-13:40 - Designing an experiment
13:40-14:20 - Summary and project description

14:20-14:35 - ***Coffee/tea break***

14:35-16:00 - Open working time

ANY QUESTIONS?